

REMARKS

The Applicants thank the Office for the careful consideration given to their application in the Office's communication mailed on 2/26/2003. In that communication, apparatus claims 17 – 29 were withdrawn due to a requirement for restriction, and the process claims, 1 – 16, remain. Claims 1 – 16 were rejected under 35 U.S.C. 103(a) as being unpatentable over Aoki (U.S. Pat. No. 5,041,271) taken with Alix et al. (U.S. Pat. No. 5,871,703) taken with Senjo et al. (U.S. Pat. No. 4,035,470).

The Applicants and their attorney held a telephone interview with the Office on 7/22/2003. The Applicants submitted a Telephone Interview Summary on 7/23/2003. These Remarks will address the numbered items discussed in the telephone interview in order. These Remarks will also refer to the numbered paragraphs of the Declaration Traversing Rejection submitted herewith.

1. SO_x to NO_x Ratio. In the telephone interview, the parties agreed that placing the limitations of Claim 5 into Claim 1 would likely make Claim 1 allowable. Claim 1 has been amended in this communication to do just that, and Claim 5 has been canceled.

The Office invited the Applicants to provide material demonstrating the unexpected results of the claimed ratios. This material is provided in the Declaration, paragraphs 6 – 7.

2. Substituting the DBD of Alix or E-Beam of Aoki for DBD of Present Invention.

The Office invited the Applicants to differentiate the results of the e-beam process of Aoki and

the DBD process of the old Alix patent with the process of the present invention. This is explained in the Declaration, paragraphs 6 and 8.

3. Using the Aoki Process to Remove Hg in Addition to NO₂ and SO₂. The Applicants offered to submit a written argument why it would not be obvious to oxidize Hg with the e-beam process of Aoki. This argument is submitted herewith in the Declaration, paragraph 9.

4. Using the Wet ESP of Alix in the Aoki Process. The Applicants agreed to provide a written argument why the Aoki patent should be construed as teaching the use of dry ESPs only, and not wet ESPs such as that taught by Alix. This argument is submitted herewith in the Declaration, paragraph 10.

For the foregoing reasons, the Applicants respectfully request reconsideration of the rejection of claims 1 – 16. The Office is urged to phone the Applicants' attorney to resolve any remaining issues in the hope of a speedy allowance of this case.


Date: August 26, 2003

Reg. No.: 39,163

Tel. No.: (603) 766-1910

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Respectfully submitted,



(Signature of Attorney)

Phillip E. Decker

Attorney for Applicants

Decker Law Office

1 New Hampshire Ave., Suite 125

Portsmouth, NH 03801

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Attorney's Docket No. AL.US.9**PATENT****IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re Application of:	Duncan, et al.]	
Serial No.:	09/683,267]	Examiner: Lish
Confirmation No.:	3355]	
Filed:	12/06/2001]	Group Art Unit: 1754
For:	NO _x , Hg, and SO ₂ REMOVAL]	
	USING AMMONIA]	

**Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450**

**DECLARATION TRAVERSING REJECTION
37 CFR 1.132**

To the Commissioner for Patents:

I, Dr. Christopher McLarnon, being duly sworn, declare as follows:

- 1. That I am one of the inventors named in the above-captioned patent application.**
- 2. That I have a Ph.D. in Chemical Engineering and that I have significant practical experience in this field, particularly in the area of air pollution control.**
- 3. That I am the Vice President of Research and Development of Powerspan Corp., the assignee of the present invention, having a primary place of business at 54 Old Bay Road, P.O. Box 219, New Durham, NH 03855.**

4. That I am familiar with the claimed invention, namely, a process for removing SO_2 , NO, and NO_2 from a gas stream comprising the steps of a) oxidizing at least a portion of NO in a gas stream to NO_2 with an oxidizing means resulting in a mole ratio of SO_2 to NO_2 of at least 2.5 to 1, followed by b) scrubbing at least a portion of SO_2 , NO, and NO_2 from the gas stream with a scrubbing solution comprising ammonia, and having a pH between 6 and 8, and c) removing at least a portion of any ammonia aerosols generated from the scrubbing step from the gas stream with an aerosol removal means.

5. That, on account of my education, position, and experience, I consider myself to be an expert in the field of chemical reactions used for air pollution control.

6. That the Applicants' process differs from the Aoki process of U.S. Pat. No. 5,041,271 in that the Applicants' process converts a *small* portion of the SO_2 (~10%) in the incoming flue gas to higher oxides (e.g. SO_3 and H_2SO_4). The electron beam process of Aoki converts a *substantial* portion of SO_2 in the oxidizing step as has been shown by the Suzuki et al.¹ and Person et al.² The literature shows that up to 50% of the SO_2 is converted in the e-beam process when 90% conversion of NO is achieved. Oxidation of a large portion of SO_2 in the oxidizing step makes the SO_2 unavailable to perform the chemical reduction of NO_2 in the scrubbing step. Without sufficient SO_2 absorption in the scrubbing step, NO_2 produced in the oxidizing step is unaffected by the scrubber, resulting in an emission of NOx and brown discoloration of the exhaust gas plume.

7. That, in addition to the problem of converting too much SO_2 in the e-beam oxidation step of Aoki, use of e-beam technology is not viable economically due to a) the relatively high cost of

¹ Suzuki, N., et.al, "Radiation Treatment of Exhaust Gases, (IX) NO Removal in $\text{NO-H}_2\text{O-O}_2\text{-N}_2$ Mixtures Containing SO_2 ," Journal of Nuclear Science and Technology, 17(5), pp 390-392, May 1980.

² Person, J.C., et. al, "Final Report for A Unified Projection of the Performance and Economics of Radiation Initiated NOx/SOx Emission Control Technologies," Prepared for U.S. Department of Energy under Contract No. DE-AC22-84PC70259.

an electron beam power supply, and b) the need to shield personnel from the operating power supply, which produces harmful x-ray radiation. Electron beam technology has been available for over twenty years but has only been used in limited commercial operations due to its economic limitations. The dielectric barrier discharge process is an economical alternative for application to NO and SO₂ oxidation in flue gas streams.

8. That the Alix patent, U.S. Pat. No. 5,871,703, describes a process in which NO_x is converted to nitric acid and SO₂ is converted to sulfuric acid. The Applicants' process does not require conversion of NO_x to nitric acid in order to remove NO_x from the gas stream. Instead the barrier discharge reactor is operated in such a way that the majority of NO_x converted in the oxidizing step forms NO₂, which is removed in the subsequent scrubbing step. Use of a hydrocarbon reagent in the barrier discharge reactor such as ethylene, as described in the application, further promotes the formation of NO₂ and reduces the electrical power requirement of the oxidizing step. For example, operating a laboratory barrier discharge reactor under typical flue gas conditions and at a power of 15 W/scfm (energy per volume of flue gas treated) results in conversion of 25% of the incoming NO_x to nitric acid and 22% to NO₂. Removing NO₂ with the scrubbing step allows the process to achieve 57% NO_x removal, a level requiring greater than 30 W/scfm to achieve by the process of Alix. Use of ethylene in the barrier discharge reactor further increases the conversion to NO₂ at 15 W/scfm (to 55%) and the conversion to nitric acid to 40%. Scrubbing NO₂ in the scrubbing step allows for 95% NO_x removal at 15 W/scfm through the use of ethylene in the applicant's process.

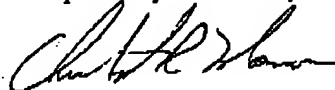
9. That the electron beam process of Aoki creates highly energetic electrons (1,000 to 1,000,000 eV) that result in dissociation of compounds (eg: N₂ → 2N) that cause chemical reduction as well as those that lead to oxidation. This is seen in the literature's reported reduction to N₂ and O₂ of a portion of converted NO by the e-beam process. The presence of reducing compounds in the gas produced by the e-beam process may result in the reduction to elemental Hg of the oxidized Hg produced by the action of the oxidizing radicals. No information in the literature has been found that establishes the predominant effect on Hg of the

presence of both oxidizing and reducing radicals. By comparison, the barrier discharge process creates electrons of an average energy of ~5 eV, too low to produce the reducing radicals formed in the e-beam process, leaving only the oxidation pathways available.

10. That the process of Aoki in which the by-product is captured in a dust collecting means precludes the economical use of an wet electrostatic precipitator (ESP). Installation of a wet ESP for collection of only the salts produced from NO_x and SO_2 is economically unattractive because the wet ESP is substantially more expensive than a dry ESP, and its use requires the addition of a drying step for the collected salts. Use of the wet ESP only becomes economically viable when collecting the products of a process that produces droplets and aerosols, such as the process of the subject patent application that removes NO_x , SO_2 and mercury.

I declare further that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Respectfully submitted,



Dr. Christopher McLarnon

Date: August 26, 2003
Tel. No.: (603) 859-2500

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